DOCUMENT RESUME

ED 478 763 SP 041 672

AUTHOR	Bailey, Lora B.
TITLE	Standards-Based Mathematics Training To Improve Teacher's Content Knowledge and Enhance Parental Support for Student Learning.
PUB DATE	2003-00-00
NOTE	14p.
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	*Academic Standards; Elementary Education; *Elementary School Mathematics; *Homework; *Mathematics Education; *Parent Responsibility; Pedagogical Content Knowledge; Scores; Standardized Tests; *Teaching Methods

ABSTRACT

The purpose of this research is to provide elementary mathematics teachers strategies that will enhance their knowledge of standards-based mathematics content and pedagogy and to increase parents' and homework help-line employees' knowledge of standards-based mathematics concepts. Teacher participation in standards-based mathematics activities is intended to promote greater access to developmentally effective mathematics instruction for underachieving students. Parent and homework help-line training is intended to provide support to students as they attempt to complete standards-based homework assignments. The project work is intended to impact students' mathematics standardized test scores, mathematics classroom grades, teachers' mathematical content knowledge, and parental support. (Contains 29 references.) (Author/SM)

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ED 478 763

Standards-Based Mathematics Training to Improve Teacher's Content Knowledge and Enhance Parental Support for Student Learning

Lora B. Bailey, Ph.D.

Assistant Professor

University of South Carolina

College of Education

107-D Wardlaw College; Columbia SC 29208; Lbailey@sc.edu; (w) 803-777-6240; (h) 803-414-9531

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Abstract

Standards-Based Mathematics Training to Improve Teacher's Content Knowledge and Enhance Parental Support for Student Learning

The purpose of this research is to provide elementary mathematics teachers strategies that will enhance their knowledge of standards-based mathematics content and pedagogy, and to increase parents' and homework help-line employees' knowledge of standards-based mathematics concepts. Teacher participation in standards-based mathematics activities are intended to promote greater access to developmentally effective mathematics instruction for underachieving students. Parent and homework help-line training is intended to provide support to students as they attempt to complete standards-based homework assignments. The project work is intended to impact students' mathematics standardized test scores, mathematics classroom grades, teachers' mathematical content knowledge, and parental support.

Standards-Based Mathematics Training to Improve Teacher's Content Knowledge and Enhance Parental Support for Student Learning

Teachers and parents from low performing schools that serve underrepresented student populations often need training to increase their mathematical content knowledge and understandings of national and state mathematics standards. The standards-based mathematics training will provide teachers and parents with strategies to better serve these students. The objectives of the standards-based mathematics training are to:

1. Increase the use of developmentally appropriate mathematics activities and lessons in elementary mathematics classrooms
2. Increase teacher knowledge of mathematics content, pedagogy, and developmentally appropriate mathematics activities
3. Increase help-line volunteers' abilities to assist students during the completion of standards-based mathematics homework assignments
4. Increase parent knowledge and ability to support students during the completion of standards-based assignments
5. Improve students' mathematics performance on standardized tests
6. Improve students' classroom mathematics performance

A development team should be formed to plan and design the elementary standards-based mathematics workshop. The team should consist of mathematics education professors, at least one Department of Mathematics professor, local and district mathematics curriculum specialists, elementary mathematics teachers, parents and homework help-line assistants. The workshop should be focused on increasing teachers' and parents' knowledge of elementary mathematics content standards, to include (a) numbers and operations; (b) algebra; (c) measurement; and (d)

data analysis and probability. Trainers should focus on enabling teachers to use standards-based instruction to promote (a) equity; (b) a developmentally effective mathematics curriculum; (c) improved mathematics teaching; (d) increased student learning; (e) improved assessment based on developmentally effective strategies and (f) adequate incorporation of mathematics technology. The training should involve at least 45 hours of trainer – teacher interactions; some of this time should be in the form of follow-up trainer-teacher collaboration.

Parents should also be privy to training because many have limited knowledge of basic pedagogy and strategies for elementary math operations such as addition, subtraction, multiplication and etc. (Johnson, 2002). Often, they are limited to their own understanding of these concepts. Therefore, parents need a fundamental understanding of mathematical ideas that produce these strategies and algorithms. For example, understanding the concepts of place value and base-10 arithmetic will help parents to have a more open approach to the standards-based explorations undertaken by their children. Most college level mathematics courses do not revisit the fundamental ideas that under gird basic arithmetic. Most parents and college students, including homework help-line workers, were exposed to these ideas in a traditional setting before they conceptualized abstract concepts. The workshop must be designed to reintroduce them to these fundamental concepts in the context of NCTM and state standards as abstract thinkers.

Scientifically-Based Research Evidence of Project Activities

Workshop training activities must be based on scientific research and consistent with the local school and district needs. Research related to instructional approaches for underrepresented student populations must be conducted by project directors to determine effective measures for engaging students' thinking, and to utilizing strategies for establishing better home-school relationships that will support students' academic achievement (Ascher, 1988; Bracey, 1996; DeLoache & DeMendoza, 1987; Epstein, 1993; Heath, 1982; Hiebert and Pearson; Marcon, 1998; McCarthey, 2000; Snow, 1999, Sulzby & Teale, 1991). Early intervention is the most effective strategy for empowering students to

achieve academic success (Snow, 1999; McCarthey, 2000). Therefore, the workshops must target early childhood students with low-SESs. Project work should be focused on helping low mathematical achievers build an early mathematical foundation that will serve as a basis for understanding more complex mathematical concepts.

NCTM: Research Based Instruction to Improve Teacher Quality and Engage Students' Mathematics Thinking

District administrators should consider instituting new approaches to teaching mathematics based on current mathematics research. The National Council of Teachers of Mathematics (NCTM) provides the most reliable and comprehensive research for mathematics reform. Its compilation of principles and standards for school mathematics encompasses recommendations for teaching mathematics to students in pre-kindergarten through grade 12 (NCTM, 2000).

According to NCTM Principles (2000), mathematics classrooms, individual schools and districts should ensure that all students have access to high quality, engaging mathematics instruction regardless of the race, gender or class. Researchers recommend that mathematics curricula offer all students opportunities to learn important mathematics concepts and procedures with understanding (Charelesworth & Lind, 2000; NCTM, 2000; Rock & Shaw, 2000). This negates the traditional "memorization" of mathematics facts. This recommendation is grounded on facilitating students' abilities to use their current knowledge to connect to new mathematics concepts.

National and state mathematics standards were designed as a blue print for teachers to facilitate children's understanding of mathematics concepts using developmentally effective strategies. Nevertheless, nationally, teachers find it difficult to improve student outcomes using research-based instruction without adequate parental support (Comer & Haynes, 1991; Epstein, 1988; Epstein & Dauber, 1991; Swick, 1997; Swick & Graves, 1993). Therefore, training parents to assist their children during the completion of homework should increase students' outcomes (Cooper, Jackson, Nye & Lindsay, 2001; Swick & Graves, 1993; Bryan, Burstein & Bryan, 2001).

Methodology

Data Collection

The workshop training team must gather data relevant for creating the training activities for elementary mathematics teachers and parents. Student data, including standardized test scores and mathematics grades must be gathered prior to the training for post project comparison purposes. It is also important to gather demographic data for students and parent participants, including whether or not students receive free or reduced lunches.

Project directors should collect standardized and classroom mathematics grades from students receiving standards-based instruction over the course of five-years. These students should be tracked to evaluate long-term success of the training. This data should be used in a longitudinal study to provide an argument for the use of research-based instruction to improve: (a) student performance in mathematics classes; (b) student math performance on standardized tests; (c) teacher mathematics content knowledge, and (d) parental involvement during the completion of interactive homework. The following sections will address methods for conducting designing and conducting teacher and parent/homework help line employee workshop.

Strategies

Standards-Based Mathematics Workshop for Teachers. The teacher workshop will enable them to design standards-based mathematics assignments using an inquiry approach. The promising and innovative approaches to teaching mathematics in this course are based on similar mathematics curricula funded by the National Science Foundation to meet NCTM standards (e.g. *Core Knowledge, Direct Instruction, and High/Scope K-3 Model*). The American Association for the Advancement of Science also identified each of these NSF funded and Northwest Regional Educational Laboratory recommended projects as exemplary early childhood and elementary reform models (Gorrell, Bailey,

2000). Features unique to these programs include an emphasis on problem-solving, higher order thinking skills, representations, communication, and mathematical reasoning.

The training for teachers must emphasize strategies for designing standards-based mathematics lessons and homework. Information will threaded to develop algebraic thinking in a variety of contexts. The NCTM and state standards to be emphasized are: problem solving, number sense and numeration, algorithms for whole number operations, mathematical reasoning, connecting mathematical concepts and data analysis and elementary probability and statistics. Problem solving should also address geometry and spatial sense by emphasizing pictorial representation and interpretation.

This workshop should also focus on using computer software and web-based resources to support instruction of content standards in the elementary grades. Several of the new elementary school curricula have integrated these activities within their materials. For example, the www.CoolMath.com enables students to practice numbers and operations and realistic problem solving in way that facilitates reasoning and self-management. Additional training sessions should be conducted for new elementary school teachers, and incrementally throughout the five-year project period, utilizing project directors' observations, district level feedback, teacher feedback and parental feedback.

Standards-Based Mathematics Workshop for Parents and Homework Help-line Employees. Homework workshops should focus on training parents and homework hot-line employees how to interact with students during the completion of Standards Based Mathematics homework. The objectives for homework training must be to help parents and homework help-line assistants to:

1. Learn what the national and state mathematics content standards are for the K-5 elementary grades
2. Understand national and state mathematics principles related to the elementary grades
3. Know mathematics concepts taught in K-5

4. Become proficient and comfortable at completing K-5 mathematics operations

5. Understand the importance of parent and adult interactions for facilitating student's mathematics knowledge

Parents and local or district homework help-line employees should be trained to develop the following NCTM and state standards to support children's mathematics learning:

- number sense and numeration
- mathematical reasoning
- problem solving
- measurement
- elementary data analysis
- and statistics/probability

Algebraic thinking should be woven throughout the parent and help-line training. Participants should be immersed in activities that will develop their understanding of concepts such as place value, double-digit addition and subtraction (number sense and numeration). Mathematical reasoning is to be developed through an introduction to basic problem solving strategies. Participants will also be trained to apply these strategies to real world problems. An understanding of elementary grade data analysis concepts should be developed through practical experiments for children and parents to complete together. Statistics and probability concepts are to be developed using activities that emphasize reading, displaying and understanding data.

Emphasis should be placed on activities and strategies that parents and children can do now to lay the groundwork for future mathematical competence. Emphasis should also be placed on training local school-based and or district homework help-line employees how to support students in the absence of parental involvement. New elementary parents and help-line workers should be trained

each year subsequent to the initial training throughout the five-year project period. Ongoing parental support should be provided based on directors' observations and participant feedback.

Impact on Student Achievement for Underrepresented Student Populations. Prior research regarding the implementation of the innovative early childhood and elementary math curriculum has shown several positive results in the area of student achievement and teacher change (Cobb, Paul, and Wheatley 1988). In addition, these curricula were developed specifically to increase mathematical knowledge of early childhood and elementary aged students. It has been shown that teachers change their perceptions about their own math knowledge as a result of teaching math content presented in an activity-oriented approach. Additionally, there is the potential to change teachers' understanding of higher level math topics as a result of assessing students' varied responses to the presented tasks (Black and William, 1998). Preliminary standardized test results reveal improvements by minority and underachieving students whose teachers implement these innovative curricula (Campbell, 1995; Griffin, Case, & Siegler, 1994; Knapp, Michael, Adelman, Marder, McCollum, Needels, Padilla, Shields, Turnbull, and Zucker, 1995; Silver & Stein, 1996). Over the course of five years, the project should equip teachers to use approaches adapted from NSF and Northwest Regional Educational Laboratory recommended curricula. The workshop should enable teachers to foster students' abilities to make connections within the identified NCTM and state mathematics standards.

Based on research, meeting and collaborations between project directors and trainers should result the development of a coherent workshop syllabus, a list of readings, assignments and activities sequenced to meet the needs of underrepresented students, increase teacher content knowledge and raise the mathematics achievement of K-5 students in general.

Summary

The workshops should focus on national and state based mathematics standards for teaching elementary students. The teacher workshop should be designed to facilitate K-5 teachers' understanding of national and state content standards, which is necessary for teaching mathematics in

developmentally appropriate ways, and facilitating active engagement and conceptual understanding. Innovative early childhood and elementary school curricula and readily available software will be also used in the development and implementation of the course. Elementary school teacher participants should be required to implement these approaches with K-5. The training should be last for 45 hours per year, and involve training new teacher during the summer for each of the five subsequent project years.

Additionally, parent and homework help-line workshops should designed to increase the likelihood that parents and homework assistants will be equipped to assist elementary mathematics students to complete standards-based homework assignments. Each year during the five-year project period, additional parents and homework help-line workers will be trained. Homework workshops will be based on Interactive Homework designs (Bailey, Silvern, Brabham & Ross, In press). Interactive Homework is intended to increase parent-child or student-adult interactions, which are essential to increased academic achievement (Cooper et al., 2001; Epstein, 1997; Bailey et al, In Press). The homework designs also encourage student reasoning and self-management skills, which are necessary for students to become proficient mathematicians (Charlesworth & Lind, 2001).

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